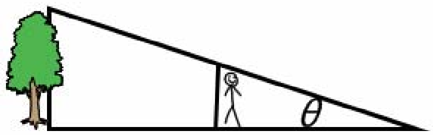
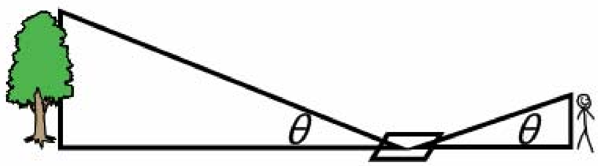
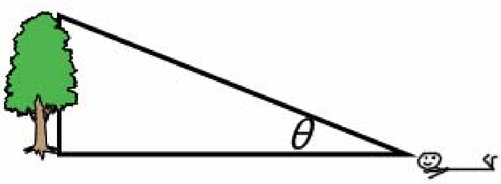
Methods of Indirect Measurement



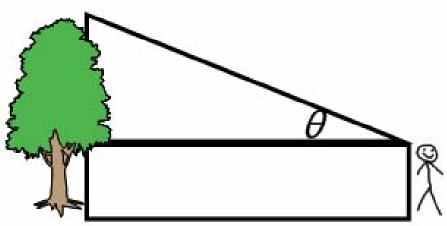
Common angle method using similar triangles. This could entail using shadows or having one person hunker down and align the top of another person's head or top of some object with the structure to be measured.



Common vertex method using a mirror to sight the reflection of the top of the object to be measured.



Trigonometric method (prone position) uses angle of elevation.



Trigonometric method (standing position) uses angle of elevation and height of the person or angle of elevation and angle of depression.

Randomly Selecting a Portion of the Park

Fold your map of the park in half, flip a coin, and then if your coin is heads, use the top half of the map, if tails, use the bottom half of the map. Fold your half of the map in half again so that there is a left half and a right half. Flip a coin again and then, if heads, use the left side of the map and if tails, use the right side. You have now chosen a particular fourth of the park map. Fold your fourth in half so that you have two eighths of the map from which to choose. Flip a coin again, and then if your coin is heads, use the top eighth of your portion of the map, if tails, use the bottom eight of that portion of the map. Mark on your map that portion of the park you have thus selected.

How tall is Colossus?
MO CLEs
D3AInt3
D2AAlg1
D2AAlg2
G1AAlg2
G1AInt2

Use 3 methods of indirect measurement to determine the height of Colossus. Indicate clearly where you took your measurements. Provide enough details so that I could stand/sit/lie down in the same place.

Find the mean and median for your 3 measurements.

Find the standard deviation for your 3 measurements.

Construct a 95% confidence interval for the mean height of measurements of Colossus.

How tall is Colossus?
MO CLEs
G1AAlg2
G1AInt2

Use 3 methods of indirect measurement to determine the height of Colossus. Use each method once. Indicate the location where you use each method.

Locations to use:

near the light pole that is next to the women's restroom located across from Shazam!,

at the entrance to Scooby-Doo: Mystery of the Scary Swamp,

at the bottom left corner of the D in DC plaza,

at the corner of the fence at the northwest corner of The Palace near Colossal Closeouts.

How tall is Superman Tower of Power?
MO CLEs
G1AAlg2
G1AInt2
D3AInt3
D2AAlg1
D2AAlg2

Use 3 methods of indirect measurement to determine the height of Superman Tower of Power. Indicate clearly where you took your measurements. Provide enough details so that I could stand/sit/lie down in the same place.

Find the mean and median for your 3 measurements.

Find the standard deviation for your 3 measurements.

Construct a 95% confidence interval for the mean height of measurements of Superman Tower of Power.

How tall is the top of the tower on Mr. Freeze?
MO CLEs
G1AAlg2
G1AInt2
D3AInt3
D2AAlg1
D2AAlg2

Use 3 methods of indirect measurement to determine the height of the tower on Mr. Freeze. Indicate clearly where you took your measurements. Provide enough details so that I could stand/sit/lie down in the same place.

Find the mean and median for your 3 measurements.

Find the standard deviation for your 3 measurements.

Construct a 95% confidence interval for the mean height of measurements of the tower on Mr. Freeze.

How tall is the peak of the roof on The Palace Theater?
MO CLEs
G1AAlg2
G1AInt2
D3AInt3
D2AAlg1
D2AAlg2

Use 3 methods of indirect measurement to determine the height of the peak of the roof of The Palace Theater. Indicate clearly where you took your measurements. Provide enough details so that I could stand/sit/lie down in the same place.

Find the mean and median for your 3 measurements.

Find the standard deviation for your 3 measurements.

Construct a 95% confidence interval for the mean height of measurements of the height of the peak of the roof on The Palace Theater.

How tall is peak of the roof on The Palace Theater?
MO CLEs
G1AAlg2
G1AInt2
D1CAlg1
D1CAlg2
D1CGeom

Use one or more methods of indirect measurement to determine the height of the peak of the roof of The Palace Theater. Indicate clearly where you took your measurements. Provide enough details so that I could stand/sit/lie down in the same places. Take measurements from 30 locations in all. Include the information needed to calculate the height in the space provided.

Make an appropriate graph of your calculated heights and describe the distribution of these heights.

Is there evidence that this distribution does or does not follow any particular model?

Find the mean and median for your 30 measurements.

Find the standard deviation for your 30 measurements.

Construct a 95% confidence interval for the mean height of measurements of the height of the peak of the roof on The Palace Theater.

How high is the top of the counterweight on Xcalibur?
MO CLEs
G1AAlg2
G1AInt2
D3AInt3
D2AAlg1
D2AAlg2

Use 3 methods of indirect measurement to determine the height to the top of the counterweight on Xcalibur. Indicate clearly where you took your measurements. Provide enough details so that I could stand/sit/lie down in the same place.

Find the mean and median for your 3 measurements.

Find the standard deviation for your 3 measurements.

Construct a 95% confidence interval for the mean height of measurements of the counterweight on Xcalibur.

How high is the top of the counterweight on the Rush Street Flyer?
MO CLEs
G1AAlg2
G1AInt2
D3AInt3
D2AAlg1
D2AAlg2

Use 3 methods of indirect measurement to determine the height to the top of the counterweight on the Rush Street Flyer. Indicate clearly where you took your measurements. Provide enough details so that I could stand/sit/lie down in the same place.

Find the mean and median for your 3 measurements.

Find the standard deviation for your 3 measurements.

Construct a 95% confidence interval for the mean height of measurements of the counterweight on the Rush Street Flyer.

How high is the top of the counterweight on Xcalibur?
MO CLEs
G1AAlg2
G1AInt2
D3AInt3
D2AAlg1
D2AAlg2

Use 3 methods of indirect measurement to determine the height to the top of the counterweight on Xcalibur. Indicate clearly where you took your measurements. Provide enough details so that I could stand/sit/lie down in the same places. Take measurements from 30 locations in all. Include the information needed to calculate the height in the space provided.

Make an appropriate graph of your calculated heights and describe the distribution of these heights.

Is there evidence that this distribution does or does not follow any particular model?

Find the mean and median for your 30 measurements.

Find the standard deviation for your 30 measurements.

Construct a 95% confidence interval for the mean height of measurements of the height of the counterweight on Xcalibur.

How high is the top of the counterweight on the Rush Street Flyer?
MO CLEs
G1AAlg2
G1AInt2
D3AInt3
D2AAlg1
D2AAlg2

Use 3 methods of indirect measurement to determine the height to the top of the counterweight on the Rush Street Flyer. Indicate clearly where you took your measurements. Provide enough details so that I could stand/sit/lie down in the same places. Take measurements from 30 locations in all. Include the information needed to calculate the height in the space provided.

Make an appropriate graph of your calculated heights and describe the distribution of these heights.

Is there evidence that this distribution does or does not follow any particular model?

Find the mean and median for your 30 measurements.

Find the standard deviation for your 30 measurements.

Construct a 95% confidence interval for the mean height of measurements of the height of the counterweight on the Rush Street Flyer.

Colossus in detail
MO CLEs
M2BGeom
A1BAlg1
A1BGeom
A1BInt2
A1BAlg2
A1BInt3
A2AInt2
A2AInt3
A3AInt3

How many degrees are there per gondola on Colossus?

Examine the support structures that make up the spokes on the wheel of Colossus. How many segments make up one of these spokes?

Write a recursive definition for the number of segments added during construction, as the number of spokes increased—that is, write a recursive definition that relates the number of spokes to the number of segments used.

Write a closed form definition that relates the number of spokes to the number of segments used.

Details
MO CLEs
A1BAlg1
A1BGeom
A1BInt2
A1BAlg2
A1BInt3
A2AInt2
A2AInt3
A3AInt3

Bring in a photo of some support structures or some decorative work that you find around the park. Attach the photo to this page. If you are not able to bring in a photo, then sketch the structure or decoration and attach the sketch to this page.

Write a recursive definition for the number of segments, bars, dots, bolts, or other elements added, as the number of repeated pieces increases—that is, write a recursive definition that relates the number of supporting or decorative sections to the number of segments, bars, dots, bolts, or other elements used.

Write a closed form definition that relates the number of supporting or decorative sections to the number of segments, bars, dots, bolts, or other elements used.

Circuits and Paths
MO CLEs
G4AGeom

Make a vertex-edge graph of the 8 roller coasters in the park and the pathways connecting them.

Identify the degree of each roller coaster (vertex).

Is there a path that includes every roller coaster?

Is there a simple path that includes every roller coaster?

Is there a circuit that includes every roller coaster?

Is there a Hamiltonian circuit that includes every roller coaster?

Is there an Euler circuit that includes every roller coaster?

Find a minimal spanning tree for the graph of all roller coasters.

Make a vertex-edge graph of the 3 wooden coasters (Screaming Eagle, The Boss, American Thunder).

Walk each path in this graph and use the times to give a total weight to the graph.

Find a solution to the traveling salesman problem for the graph of the 3 wooden coasters.

Make a vertex-edge graph of the 5 steel coasters (Ninja, Batman The Ride, River King Mine Train, Pandemonium, Mr. Freeze).

Make the above graph a directed graph to show dominance based on some aspect of the rides of your choice, such as height, speed, or length.

Walk each path in this graph and use the times to give a total weight to the graph.

Find a solution to the traveling salesman problem for the graph of the 5 steel coasters.

Work
MO CLEs
N2DAlg1
N2DGeom
N2DInt2
N2DAlg2
N2DInt3

Work is defined as a force times a distance. For English units, we have force measured in pounds and distance measured in feet, so what would the units be?

Suppose you win a stuffed animal at the park and it weighs 5 pounds. If you carry it from the entrance to the Screaming Eagle to the entrance to Batman The Ride, how much work is done carrying it?

The Slingshot
MO CLEs
N2DAlg1
N2DGeom
N2DInt2
N2DAlg2
N2DInt3
N3EAlg1
N3EGeom
N3EInt2
N3EAlg2
N3EInt3

The Slingshot uses springs and pulleys to launch a rider or two up to 22 stories in the air. We're going to simplify the situation by ignoring the effect of the pulleys. A story could measure anywhere from 8 to 14 feet. In a launch of a 150 pound person, about how much work is done? Include units.

Determine the number of springs used on The Slingshot.

Determine how much work is done on each spring.

If each spring is stretched by this work from 46 inches to *** inches, what is the spring constant, according to Hooke's Law?

Concession Duty
MO CLEs
A3AAlg1
A3AGeom
A3AInt2
A3AAlg2
A3AInt3
A4AAlg1
A4AGeom
A4AInt2
A4AAlg2
A4AInt3

In ***, Friar Tuck's Turkey Legs were sold for $*** and *** turkey legs were sold that season. In ***, the turkey legs were sold for $*** each and visitors bought *** legs that year.

Write a function that relates the price per turkey leg to the number that are sold.

This year, Friar Tuck's is selling turkey legs for $__________ each.

Use your function to estimate the number of turkey legs that will be sold this year.

How much revenue was brought in on turkey legs in ***?

How much revenue was brought in on turkey legs in ***?

How much revenue do you expect to be brought in on turkey legs this year?

Sampling
MO CLEs
D1AInt3

Fold your map of the park in half, flip a coin, and then if your coin is heads, use the top half of the map, if tails, use the bottom half of the map. Fold your half of the map in half again so that there is a left half and a right half. Flip a coin again and then, if heads, use the left side of the map and if tails, use the right side. You have now chosen a particular fourth of the park map. Fold your fourth in half so that you have two eighths of the map from which to choose. Flip a coin again, and then if your coin is heads, use the top eighth of your portion of the map, if tails, use the bottom eight of that portion of the map. Mark on your map that portion of the park you have thus selected.

Conduct an inspection of this region and count the number of trash cans.

Use this information to make an estimate for the number of trash cans in the entire park. Show your work and explain how you arrived at your answer.

Identify any potential sources of bias or error in your method.

Conduct an inspection of this region and count the number of light bulbs.

Use this information to make an estimate for the number of light bulbs in the entire park. Show your work and explain how you arrived at your answer.

Identify any potential sources of bias or error in your method.

Conduct an inspection of this region and count the number of different plant species.

Use this information to make an estimate for the number of plant species in the entire park. Show your work and explain how you arrived at your answer.

Identify any potential sources of bias or error in your method.

Spinning Rides
MO CLEs
N2DAlg1
N2DGeom
N2DInt2
N2DAlg2
N2DInt3
N3DAlg1
N3DGeom
N3DInt2
N3DAlg2
N3DInt3
N1BAlg1
N1BGeom
N1BInt2
N1BAlg2
N1BInt3

Time how long it takes the Riverview Racer to make a full revolution.

Determine the angular velocity of the ride.

Measure the radius of the ride. Include units.

Determine the distance a rider travels in one revolution. Include units.

Determine the linear velocity of a rider.

The Dragon's Wing and The Joker
MO CLEs
N2DAlg1
N2DGeom
N2DInt2
N2DAlg2
N2DInt3
N3DAlg1
N3DGeom
N3DInt2
N3DAlg2
N3DInt3
N1BAlg1
N1BGeom
N1BInt2
N1BAlg2
N1BInt3

The Dragon's Wing is a pendulum. We can use the formula $P = 2\pi\sqrt{\frac{L}{g}}$ to relate P, the period of a pendulum (the time to go from one end all the way out to the other end and back to the starting point), to L, the length of the tether used. To use this formula, length must be measured in meters and “g” equals 9.81 meters/second.

Time the period of The Dragon's Wing and use the above formula to determine the length of the cable tether that holds the riders.

The Joker is not a pendulum. Show this by using the formula that relates the period to the length of the steel tethers in order to get an estimate for “g”.

The Spinning Rides
MO CLEs
N2DAlg1
N2DGeom
N2DInt2
N2DAlg2
N2DInt3
N3DAlg1
N3DGeom
N3DInt2
N3DAlg2
N3DInt3
N1BAlg1
N1BGeom
N1BInt2
N1BAlg2
N1BInt3
A1BAlg1
A1BGeom
A1BInt2
A1BAlg2
A1BInt3
A3AAlg1
A3AGeom
A3AInt2
A3AAlg2
A3AInt3
D2CInt2
D2CAlg2

Use indirect measurement methods and estimation methods to determine an estimate for the radius of The Highland Fling. Count and time the number of revolutions per minute (rpm) for the ride. Obtain data on g-forces in the direction of the radius.

Repeat this data collection for Xcalibur.

Repeat this data collection for The Riverview Racer.

For each ride, find the product of the radius and rpm.

Graph the data for the product of the radius and rpm, compared to the g-forces experienced.

Develop a model that relates the product of the radius and rpm to the g-forces experienced.

The Roller Coasters
MO CLEs
A1DAlg1
A1DInt3
A3AAlg1
A3AGeom
A3AInt2
A3AAlg2
A3AInt3

Suppose that the roller coasters were not 3 dimensional, but rather 2 dimensional. Think about what the roller coaster would look like if we took it, cut the track in one spot, and dragged the track around so that it was all in one plane, still going up and down. This path of the track would then be like having a graph of a function.

Select two roller coasters. Identify which roller coasters you are using. Draw a sketch of the hills and valleys of these roller coasters, if they were moved around to be in a plane.

For each roller coaster you are considering, what is the minimum degree of the polynomial that would model the path of the track?

Explain why this is the minimum degree for such a polynomial.

Support structures
MO CLEs
A1BAlg1
A1BGeom
A1BInt2
A1BAlg2
A1BInt3
A2AInt2
A2AInt3
A3AInt3

Examine The Riverview Racer.

How many seats does the ride have?

Several sections of chain hold up each swing seat. How many sections of chain are there per swing seat?

If an additional swing seat could be added, how many additional sections of chain would be needed?

Write a recursive formula for the number of sections of chain on the ride as each swing seat was added during construction.

Write a closed form formula that relates the number of sections of chain on the ride to the number of swing seats.

Mr. Freeze
MO CLEs
A1DAlg1
A3AAlg1
A3AGeom
A3AInt2
A3AAlg2
A3AInt3

If Mr. Freeze's height vs. time of the ride were modeled by a function, to what family of functions would it belong? Explain.

If we consider the function that relates Mr. Freeze's height vs. distance from the station, to what family of functions would it belong? Explain.

Pandemonium
MO CLEs
D3AInt3

This will take some collaboration among class members or large group of students.

Construct a hypothesis to be tested such as the following:

Hypothesis: The cars on Pandemonium will spin more when the two heaviest people in the car are seated going backward, compared to when they are both seated on the left side of the car when starting from the station.

Hypothesis: The number of times that cars spin on Pandemonium is independent of the locations where the two heaviest people in the car are seated.

Hypothesis: The mean number of spins of the cars on Pandemonium is 3.5. That is, on average, a rider crosses changes direction with respect to the track 7 times.

Hypothesis: On Pandemonium, less than 50% of the time, a rider will enter the station for unloading in the opposite direction they left the station upon loading. That is, less than 50% of the time, riders leave the station facing one way and enter the station facing the opposite way.

Collect and analyze data to test your hypothesis.

Roller Coasters
MO CLEs
G1AAlg2
G1AInt2
N1BAlg1
N1BGeom
N1BInt2
N1BAlg2
N1BInt3
N3EAlg1
N3E Geom
N3E Int2
N3E Alg2
N3E Int3
M2EAlg1
M2E Geom
M2E Alg2
M2E Int3
D2CAlg1
D2CInt2
D2CAlg2
D2CInt3
D3AInt3

Use indirect measurement techniques to determine the height of the first hill for at least 3 roller coasters. Your teacher might direct you to measure a specific number of coasters to measure. He or she might require a particular minimum or maximum number of coasters to measure. Identify the roller coasters and their determined heights in the space provided.

Estimate the maximum speed of these roller coasters by one of the timing methods. Identify the roller coasters and their determined speeds here.

Graph the roller coasters’ speeds (y) and their heights (x).

Write an equation for a line of best fit that relates the roller coasters’ speeds (y) to their heights (x).

Explain the meaning of the slope in your equation in context. Include units.

Explain the meaning of the y intercept in your equation in context. Include units.

Suppose that Six Flags wanted to build a 205 foot high roller coaster. Use your equation to predict the speed of such a roller coaster.

Explain why your prediction might differ from the actual speed of such a roller coaster.

Suppose Six Flags wanted to build a roller coaster that travels 90 miles per hour. Use your equation to predict the height of such a roller coaster.

Experimental Probability
MO CLEs
D4AInt2
D4AAlg2
D3AInt3
D1AAlg1
D1AGeom

Collect data at the Ring Toss or at the Goblet Toss, located between the exit from Thunder River and the entrance to The Boss to estimate the probability of winning. Your teacher will set a minimum number of trials (tosses) to conduct.

Does the probability of winning change, depending on whether you throw from the left side, the right side, or the front?

Find the sample proportion of wins from your measurements.

Find the standard error for the proportion of wins from your measurements.

Construct and interpret a 95% confidence interval for the true proportion of wins.

Xcalibur
MO CLEs
G1AAlg2
G1AInt2
N1BAlg1
N1BGeom
N1BInt2
N1BAlg2
N1BInt3
N3EAlg1
N3E Geom
N3E Int2
N3E Alg2
N3E Int3
N3DAlg1
N3DGeom
N3DInt2
N3DAlg2
N3DInt3
G4BAlg1
G4BGeom
G4BInt2
G4BAlg2
G4BInt3
M2CGeom
M2EAlg1
M2E Geom

While Xcalibur is loading and unloading, look up toward the two large counterweights at the top of the ride. These two large counterweights are not enough to counterbalance the weight of the wheel, motors, and riders at the other end, so the top half of the ride is filled with water. Use indirect measurement techniques to determine the volume of water contained within the top of the ride.

Decibels
MO CLEs
A3AAlg1
A3AGeom
A3AInt2
A3AAlg2
A3AInt3
D2CAlg1
D2CInt2
D2CAlg2
D2CInt3
D3AInt3

Use a decibel meter to measure the intensity of sound at various locations around the park. Your teacher might give a minimum or maximum number of measurements to take. Estimate the average sound intensity experienced in the park.

Mr. Freeze is one of the louder rides to stand near. Mark on the map where you take decibel readings and also measure the distance from the decibel meter to the ride each time.

For each measurement, graph the sound intensity (y) and the corresponding distance from the ride (x).

Does your graph appear linear? If so, write an equation for a line of best fit that relates the sound intensity (y) and the corresponding distance from the ride (x). If not, what type of function would you propose for the relationship between x and y?

Find the mean decibel meter reading for your measurements.

Find the standard deviation for your decibel meter measurements.

Construct a 95% confidence interval for the mean sound intensity.

The lay of the land
MO CLEs
A1EAlg1
A1EInt2
A1EAlg2
A1EInt3
G1AGeom
G1AInt2
G1AAlg2
G1AInt3
G4BAlg1
G4BGeom
G4BInt2
G4BAlg2
G4BInt3

Throughout the day, as you changed positions to measure indirectly the heights assigned to you, what did you notice about the angle of elevation at each measuring location? What relationship do you notice between the terrain at these locations and their corresponding angles of elevation? What can you hypothesize about the angle of elevation and the terrain?

Angles of elevation
MO CLEs
G1AGeom
G1AInt2
G1AAlg2
G1AInt3
G4BAlg1
G4BGeom
G4BInt2
G4BAlg2
G4BInt3
N1BAlg1
N1BGeom
N1BInt2
N1BAlg2
N1BInt3

If you make an indirect measurement of some object and lie on the ground to take your angle measurement, and someone else stands in front of you taking his or her own angle measurement, what would you hypothesize is true of your angles, if the other person's line of sight is the same as your own?

Calculus Concepts 1
MO CLEs
G4BAlg1
G4BGeom
G4BInt2
G4BAlg2
G4BInt3
A3AAlg1
A3AGeom
A3AInt2
A3AAlg2
A3AInt3

1. You may obtain your own photo, though this photo of Mr. Freeze captures almost the entire ride.

2. Obtain accelerometer data (and barometric pressure data, if possible) for Mr. Freeze. That data should help you with the following problems.

Definition: Let h(t) be the function that indicates the rider's height above the ground at time t. Assume that the domain for h is limited to the portion of the ride clearly visible in the picture and you may choose to limit the domain to EITHER the portion of the ride where the train moves only forward OR only backward, if you wish.

3. Sketch a graph of h(t). Indicate on the photo and on the graph the extrema (maxima/minima) for h(t).

4. Sketch a graph of h'(t). Indicate on the photo and on the graph where, if at all, h'(t) is positive. If nowhere, why not?

5. Sketch a graph of h''(t). Indicate on the photo and on the graph where, if at all, h''(t) is positive. If nowhere, why not?

6. Regarding the function h(t), tell me what you know about continuity, differentiability, increasing/decreasing/monotonicity, and concavity. You might choose to discuss what would happen if some condition is violated; for example, what if h(t) lacked continuity, differentiability, etc.?

Calculus Concepts 2
MO CLEs
A3AAlg1
A3AGeom
A3AInt2
A3AAlg2
A3AInt3
A4AAlg1
A4AGeom
A4AInt2
A4AAlg2
A4AInt3

1. You may obtain your own photo, though this photo of Ninja captures some interesting parts of the ride.

2. If possible, obtain accelerometer data (and barometric pressure data, if also possible) for Ninja. That data should help you with the following problems.

Definition: Let h(t) be the function that indicates the rider's height above the ground at time t. Assume that the domain for h is limited to the portion of the ride clearly visible in the picture and you MAY choose to limit the domain to EITHER the <u>loop and following half loop</u> OR <u>the double corkscrew</u> portion of the ride.

3. Sketch a graph of h(t). Indicate on the photo and on the graph the extrema (maxima/minima) for h(t).

4. Sketch a graph of h'(t). Indicate on the photo and on the graph where, if at all, h'(t) is positive. If nowhere, why not?

5. Sketch a graph of h''(t). Indicate on the photo and on the graph where, if at all, h''(t) is positive. If nowhere, why not?

6. Regarding the function h(t), tell me what you know about continuity, differentiability, increasing/decreasing/monotonicity, and concavity. You might choose to discuss what would happen if some condition is violated; for example, what if h(t) lacked continuity, differentiability, etc.?

Calculus Concepts 3
MO CLEs
A3AAlg1
A3AGeom
A3AInt2
A3AAlg2
A3AInt3
A4AAlg1
A4AGeom
A4AInt2
A4AAlg2
A4AInt3

1. You may obtain your own photo, though this photo of Batman captures the initial drop, first loop, and the beginning of the roll.

2. If possible, obtain accelerometer data (and barometric pressure data, if also possible) for Batman. That data should help you with the following problems.

Definition: Let h(t) be the function that indicates the rider's height above the ground at time t. Assume that the domain for h is limited to the portion of the ride clearly visible in the picture, the ascent, drop, loop, and roll.

3. Sketch a graph of h(t). Indicate on the photo and on the graph the extrema (maxima/minima) for h(t).

4. Sketch a graph of h'(t). Indicate on the photo and on the graph where, if at all, h'(t) is positive. If nowhere, why not?

5. Sketch a graph of h''(t). Indicate on the photo and on the graph where, if at all, h''(t) is positive. If nowhere, why not?

6. Regarding the function h(t), tell me what you know about continuity, differentiability, increasing/decreasing/monotonicity, and concavity. You might choose to discuss what would happen if some condition is violated; for example, what if h(t) lacked continuity, differentiability, etc.?

Calculus Concepts 4
MO CLEs
A3AAlg1
A3AGeom
A3AInt2
A3AAlg2
A3AInt3
A4AAlg1
A4AGeom
A4AInt2
A4AAlg2
A4AInt3
A1DInt3

1. You may obtain your own photo, though this photo of a ride much like The Highland Fling captures a portion of the ride.

2. If possible, obtain accelerometer data (and barometric pressure data, if also possible) for The Highland Fling. That data should help you with the following problems.

Definition: Let h(t) be the function that indicates the rider's height above the ground at time t. Assume that the domain for h is limited to EITHER the portion of the ride in which the <u>ride tilts upward</u> OR <u>returns downward</u>.

3. Sketch a graph of h(t). Indicate on the photo and on the graph the extrema (maxima/minima) for h(t).

4. Sketch a graph of h'(t). Indicate on the photo and on the graph where, if at all, h'(t) is positive. If nowhere, why not?

5. Sketch a graph of h''(t). Indicate on the photo and on the graph where, if at all, h''(t) is positive. If nowhere, why not?

6. Regarding the function h(t), tell me what you know about continuity, differentiability, increasing/decreasing/monotonicity, and concavity. You might choose to discuss what would happen if some condition is violated; for example, what if h(t) lacked continuity, differentiability, etc.?

Calculus Concepts 5
MO CLEs
A3AAlg1
A3AGeom
A3AInt2
A3AAlg2
A3AInt3
A4AAlg1
A4AGeom
A4AInt2
A4AAlg2
A4AInt3

1. You may obtain your own photo, though this photo of "Eagle Hill" from The Screaming Eagle captures a nice portion of the hill.

2. If possible, obtain accelerometer data (and barometric pressure data, if also possible) for The Screaming Eagle. That data should help you with the following problems.

Definition: Let h(t) be the function that indicates the rider's height above the ground at time t. Assume that the domain for h is limited to the portion of the ride clearly visible in the picture, ascending Eagle Hill and then falling down Eagle Hill.

3. Sketch a graph of h(t). Indicate on the photo and on the graph the extrema (maxima/minima) for h(t).

4. Sketch a graph of h'(t). Indicate on the photo and on the graph where, if at all, h'(t) is positive. If nowhere, why not?

5. Sketch a graph of h''(t). Indicate on the photo and on the graph where, if at all, h''(t) is positive. If nowhere, why not?

6. Regarding the function h(t), tell me what you know about continuity, differentiability, increasing/decreasing/monotonicity, and concavity. You might choose to discuss what would happen if some condition is violated; for example, what if h(t) lacked continuity, differentiability, etc.?

Calculus Concepts 6
MO CLEs
A3AAlg1
A3AGeom
A3AInt2
A3AAlg2
A3AInt3
A4AAlg1
A4AGeom
A4AInt2
A4AAlg2
A4AInt3
A1DInt3

1. You may obtain your own photo, though this photo of Sea Dragon (located at Worlds of Fun in Kansas City) is very similar to one you would get of The Joker, Inc. and captures almost the entire ride.

2. If possible, obtain accelerometer data (and barometric pressure data, if also possible) for The Joker, Inc.. That data should help you with the following problems.

Definition: Let h(t) be the function that indicates the rider's height above the ground at time t. Assume that the domain for h is the entire time the ride is in motion.

3. Sketch a graph of h(t). Indicate on the photo and on the graph the extrema (maxima/minima) for h(t).

4. Sketch a graph of h'(t). Indicate on the photo and on the graph where, if at all, h'(t) is positive. If nowhere, why not?

5. Sketch a graph of h’’(t). Indicate on the photo and on the graph where, if at all, h’’(t) is positive. If nowhere, why not?

6. Regarding the function h(t), tell me what you know about continuity, differentiability, increasing/decreasing/monotonicity, and concavity. You might choose to discuss what would happen if some condition is violated; for example, what if h(t) lacked continuity, differentiability, etc.?

Calculus Concepts 7
MO CLEs
A3AAlg1
A3AGeom
A3AInt2
A3AAlg2
A3AInt3
A4AAlg1
A4AGeom
A4AInt2
A4AAlg2
A4AInt3

1. You may obtain your own photo, though these photos of The Screaming Eagle captures the entire first drop and first hill .

2. If possible, obtain accelerometer data (and barometric pressure data, if also possible) for The Screaming Eagle. That data should help you with the following problems.

Definition: Let h(t) be the function that indicates the rider's height above the ground at time t. Assume that the domain for h is limited to the portion of the ride clearly visible in the picture. You <u>may</u> choose to exclude from the domain the ascent, if you wish.

3. Sketch a graph of h(t). Indicate on the photo and on the graph the extrema (maxima/minima) for h(t).

4. Sketch a graph of h'(t). Indicate on the photo and on the graph where, if at all, h'(t) is positive. If nowhere, why not?

5. Sketch a graph of h''(t). Indicate on the photo and on the graph where, if at all, h''(t) is positive. If nowhere, why not?

6. Regarding the function h(t), tell me what you know about continuity, differentiability, increasing/decreasing/monotonicity, and concavity. You might choose to discuss what would happen if some condition is violated; for example, what if h(t) lacked continuity, differentiability, etc.?

Calculus Concepts 8
MO CLEs
A3AAlg1
A3AGeom
A3AInt2
A3AAlg2
A3AInt3
A4AAlg1
A4AGeom
A4AInt2
A4AAlg2
A4AInt3
A1DInt3

1. You may obtain your own photo, though this photo of Ripcord (a ride at Worlds of Fun) is similar to a photo you would get of The Dragon's Wing.

2. If possible, obtain accelerometer data (and barometric pressure data, if also possible) for The Dragon's Wing. That data should help you with the following problems.

Definition: Let h(t) be the function that indicates the rider's height above the ground at time t. Assume that the domain for h is the total period of time in which the rider is in motion.

3. Sketch a graph of h(t). Indicate on the photo and on the graph the extrema (maxima/minima) for h(t).

4. Sketch a graph of h'(t). Indicate on the photo and on the graph where, if at all, h'(t) is positive. If nowhere, why not?

5. Sketch a graph of h''(t). Indicate on the photo and on the graph where, if at all, h''(t) is positive. If nowhere, why not?

6. Regarding the function h(t), tell me what you know about continuity, differentiability, increasing/decreasing/monotonicity, and concavity. You might choose to discuss what would happen if some condition is violated; for example, what if h(t) lacked continuity, differentiability, etc.

Calculus Concepts 9
MO CLEs
A3AAlg1
A3AGeom
A3AInt2
A3AAlg2
A3AInt3
A4AAlg1
A4AGeom
A4AInt2
A4AAlg2
A4AInt3
M2EAlg2
M2EInt3
A1DInt2
A1EAlg1
A1EInt2
A1EAlg2
A1EInt3
A2AAlg1
A2A Int2
A2A Alg2
A4AAlg1
A4A Int2

For Calculus BC Students

1. You may obtain your own photo of a hill on a roller coaster. It is best to find one that is "profile" like these:

2. If possible, obtain accelerometer data (and barometric pressure data, if also possible) for the roller coaster you study. That data should help you with the following problems.

Definition: Let y(t) be the function that indicates the rider's height above the ground at time t. You may assume that the domain for y is limited to the portion of the ride from the top of the hill to the point of inflection; you can see such a portion in the photos above. Let x(t) be the function that indicates the rider's position left or right of the top of the hill at time t.

3. Time how many seconds it takes for a train to pass over the top of a particular hill, divide that time into the length of the train to find its horizontal velocity x'(t) at the top of the hill you're examining?

4. A free fall hill shape gives a rider a weightless sensation. To give this weightless sensation over a hill, the hill is designed to have the same shape as the path of a ball being thrown off the top of a hill. Shape is determined by how fast the roller coaster car travels over the hill. The faster the coaster travels over the hill the wider the hill must be. The vertical velocity $y'(t)=0$ at the top of the hill you're examining. Knowing that the hill must follow freefall, the position function $y(t)= -9.8t^2 + y(0)$, where $y(0)$ is the initial height at the top of the hill. Complete this equation.

5. Find the antiderivative (indefinite integral) of the $x'(t)$ equation from part 3 to find the horizontal position function $x(t)$. We're assuming that friction is negligible for the distance we are examining.

6. Solve the equation from part 5 for t and then substitute that expression into the equation from part 4 so that you have a rectangular equation for the shape of the hill rather than two parametric equations for the location of the train.

Calculus Invent-a-Lab
MO CLEs
A4AAlg1
A4AGeom
A4AInt2
A4AAlg2
A4AInt3
G1BInt2
G1BInt3
M2EInt2
M2EInt3
M2CGeom
A1DInt2
A1DAlg2
A1DInt3
A1EAlg1
A1EInt2
A1EInt3
A2AAlg2
A2AInt3
A2BAlg1
A2BGeom
A2BInt2
A2BInt3

Activity: Develop a specific lab activity (that could be carried out successfully by a student in a high school calculus course and that draws upon one or more items from the topic list below. Describe the ride(s) or specific section(s) of the ride(s), the measurements that would need to be taken or estimated and the equipment or instruments that would be needed, the calculations that would need to be done, the instruments that should be used, and the quality expected of the end results.

Assessment: Does the activity display a good understanding of the underlying calculus concepts? Is it feasible? Does it present an element of challenge to the student's ability or knowledge (or both)?

Topic list:
Limits
Intermediate Value Theorem
Derivatives
Related Rates
Approximations of derivatives
Maximum or minimum
Integrals
Approximations of integrals
Differential equations

Newton’s Law of Cooling
Work (not yet covered in calc, but will be after the ap exams)
Fluid force and pressure (not yet covered in calc, but will be after the ap exams)
Hyperbolic functions (not yet covered in calc, but will be after the ap exams)
Center of mass (not yet covered in calc, but will be after the ap exams)

Calculus Pedestrian Flow Rate at Six Flags Activity
MO CLEs
A4AAlg1
A4AGeom
A4AInt2
A4AAlg2
A4AInt3
D1AAlg1
D1AGeom

1. Find some location in the park where people walk past, through, over, or under. Identify the location very clearly (How clearly? So that someone could find the exact spot without any doubt.) here:

2. Count the number of people who pass by, through, over, or under that location, but count and record only in 1 minute intervals and only for those times in the table below. Use a stopwatch, watch, or a cell phone for the times. So, <u>for example</u>, if you time while eating lunch, you <u>could</u> time the following intervals:

11:03-11:04, 11:04-11:05, 11:05-11:06, 11:07-11:08, 11:10-11:11, 11:12-11:13, 11:13-11:14, 11:14-11:15

Time Interval	1st minute	2nd minute	3rd minute	5th minute	8th minute	10th minute	11th minute	12th minute
Number of People Passing								

3. Let P(t) be the function that describes the flow of people by this location where t is time in minutes and P(t) is measures in people per minute. Make and clearly label a reasonable graph of P(t) for the 12 minute interval you have timed.

4. Use the data you collected to estimate P ‘(2). Show your work and be sure to explain what P ‘(2) would mean with units.

5. Use the data you collected to find a <u>right approximation</u> and a <u>trapezoidal approximation</u> for $\int_{1}^{12} P(t)dt$. Show your work and be sure to explain what this would mean with units.

Calculus Scavenger Hunt
MO CLEs
M2EAlg2
M2EInt3
A1DInt2
A1DInt3
A4AAlg1
A4AGeom
A4AInt2
A4AAlg2
A4AInt3
M2CGeom

Find a place at Six Flags that exhibits an example of each of the descriptions below. **Identify**, **Sketch** and **Justify.** Use the back sides of the pages, if necessary. The same ride may be used more than once or not at all. Not all of the items are on rides. Not every ride will be open that day (you can include the closed rides). Be sure to describe the location fully. Do not just give the name of the ride/booth/building; tell where (on that ride/booth/building) it occurs, making a sketch as well. These are fully right or considered wrong, so it is a good idea to work with others. Extra credit will be given for unique (not used by anyone else) solutions, so it is a good idea to help one another come up with different examples! Remember to **Identify**, **Sketch** and **Justify.**

Constant Horizontal Velocity	Constant Vertical Velocity
Constant Speed, but NOT constant velocity	Acceleration in the horizontal direction

Acceleration in the vertical direction	Periodic Motion
Roller Coaster Track is Concave Up	Roller Coaster Track is Concave Down
Roller Coaster Track is Increasing	Roller Coaster Track is Decreasing

Free Fall	Velocity is zero, but the acceleration is non-zero
Volume of Revolution could be determined	Discontinuity would mean that someone could die or be seriously injured
Differentiability was important when someone designed this	Horizontal Asymptote

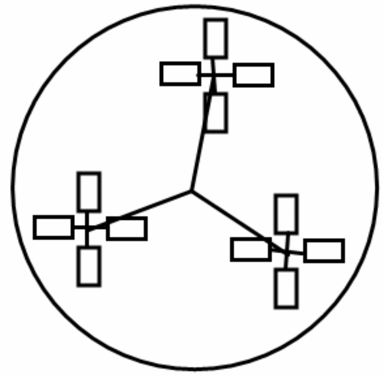
Vertical Asymptote	Extrema
Mean Value Theorem or Rolle’s Theorem	

Scrambler Rides -

SHAZAM!

MO CLEs

M2EAlg2
M2EInt3
A1DInt3
A4AAlg1
A4AGeom
A4AInt2
A4AAlg2
A4AInt3
A3AAlg1
A3AGeom
A3AInt2
A3AAlg2
A3AInt3



DATA:

Radius of primary axis (measured from center of ride to center of car cluster): ________

Radius of secondary axis (measured from center of car cluster to center of car): ________

Indicate on the diagram above the directions of rotation (as seen from above)

Time for one rotation of the total ride: ________

Time for one rotation of the car cluster: ________

Maximum lateral acceleration ($\mathbf{a_L}$): __________ g's (measured on the ride at full speed)

Minimum lateral acceleration ($\mathbf{a_L}$): __________ g's (measured on the ride at full speed)

In the problem that follows, ignore the fact that the entire ride is set at an angle to the horizontal. Consider the ride as if it were running in a horizontal manner. This is a place where your expertise in calculus will shine through. Good luck.

PROBLEM

(1) Given the rotation speed and the radius of the car cluster, write an equation to describe the position vs. time for an individual car in the frame of reference of the car cluster.

(2) Given the rotation speed and the radius of the car cluster on the total ride platform, write an equation to describe the ride position vs. time for a car cluster in the frame of reference of the stationary ground.

(3) Add the results of your two equations to predict the overall position vs. time of an individual car relative to the stationary ground. [This can be plotted on a graphing calculator if you have one with you. Hint: polar coordinates.]

(4) Write the overall velocity vs. time equation for an individual car relative to the stationary ground.

(5) Find the maximum and minimum accelerations (dv/dt) of an individual car as predicted by your equation.

(6) Finally, compare your measured results with the calculated values.

The Highland Fling-- Calculus

MO CLEs

G1AAlg2
G1AInt2
M2BGeom
M2CGeom

Use indirect measurement techniques to find the dimensions of the wheel of the Highland Fling, the length of the giant arm that holds the wheel, and the number of degrees through which the giant arm passes. Calculate the volume swept out by the wheel as is rotates from horizontal to vertical.

Thunder River 1 – Calculus
MO CLEs
G1AAlg2
G1AInt2
M2EAlg1
M2EGeom
M2EAlg2
M2EInt3
M2CGeom

Use indirect measurement techniques to estimate the dimensions of the water storage pool adjacent to Thunder River. Assume that the pool is a cylinder. Calculate the work done in pumping the water into (or out of) the pool through a pipe in the bottom of the pool. Remember that water weighs 62.4 pounds per square foot.

Thunder River 2 – Calculus
MO CLEs
G1AAlg2
G1AInt2
M2EAlg1
M2EGeom
M2EAlg2
M2EInt3
M2CGeom

Use indirect measurement techniques to estimate the dimensions of the doors that hold back the water in the water storage pool adjacent to thunder river. Calculate the fluid force of the water against the doors when closed. Remember that water weighs 62.4 pounds per square foot.

Hypothesis Testing and Confidence Intervals
MO CLEs
D1AAlg1
D1AGeom
D1CAlg1
D1CGeom
D1CAlg2
D1CInt3
D2AAlg1
D2AInt2
D2AAlg2
D2CAlg1
D2CInt2
D2CAlg2
D2CInt3
D3AAlg1
D3AInt3

Hypothesis: The time for a circuit on Mr. Freeze and the temperature are associated.

Hypothesis: There is a positive association between the time a guest stays at the park and the number of food products purchased.

Hypothesis: There is no association between the time for a ride and the wait time for rides.

Hypothesis: Gender and ride preference are independent variables.

Construct an interval estimate for the level of Chlorine in the water used in a particular ride.

Hypothesis: The time for a coaster to make a circuit is not associated with the total weight of the riders.

Construct an interval estimate for the percent of Batman riders who also plan to ride Mr. Freeze.

Construct an interval estimate for the average time (duration) for a particular ride.

Construct an interval estimate for the difference in average wait times for two rides.

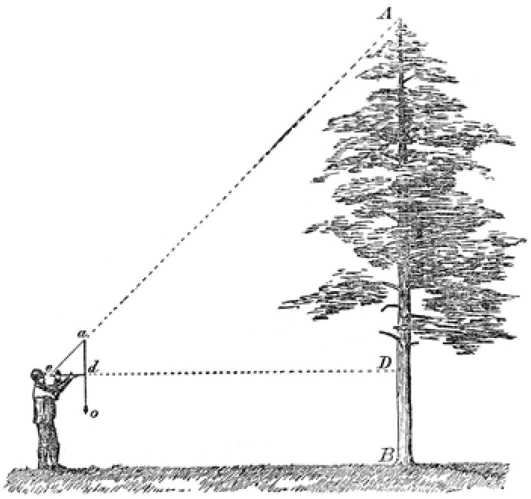
Hypothesis: There is a significant difference in pulse between those who eat peppermint candy while in line for Mr. Freeze and those who do not eat peppermint candy while in line for Mr. Freeze.

Hypothesis: There is a significant difference in percent of men who indicate that they like to ride The Boss and the percent of women who indicate they like to ride The Boss.

Hypothesis: There is an association between the time a guest leaves the park and the guest's satisfaction with the park, as measured on a student-generated survey.

Vertex-Edge Graphs
MO CLEs
G4AGeom

Construct a Hamiltonian Circuit that could be followed to water hanging baskets, empty trash, or clean restrooms.



Adapted with permission
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Parkway West High School
Ballwin, Missouri

November 15, 2008

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MO CLEs
G1AINt2
G1AAlg2
N1BAlg1
N1BGeom
N1BAlg2
N1BInt2
N1BInt3
G4AGeom
G4AInt3
G4BAlg1
G4BGeom
G4BAlg2
G4BInt2
G4BInt3

Name ____

Partners' names

____

____

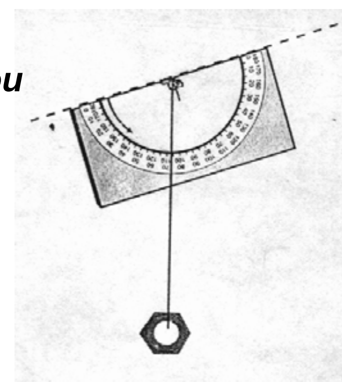
____

Finding Measurements Indirectly Using Trigonometry

Due date for project: _________________________

Your task is to find the height of one corner of a building or other structure at Six Flags using an angle measuring device and trigonometry.

Building the Clinometer



The first part of your task is to build the clinometer you will use for measuring angles.

You will need the following materials:

Protractor (these can be found online)
rectangular-shaped piece of cardboard
small straw or coffee stirrer
tape
light-weight string or thread
a weight (such as a fishing weight or a metal washer or nut)

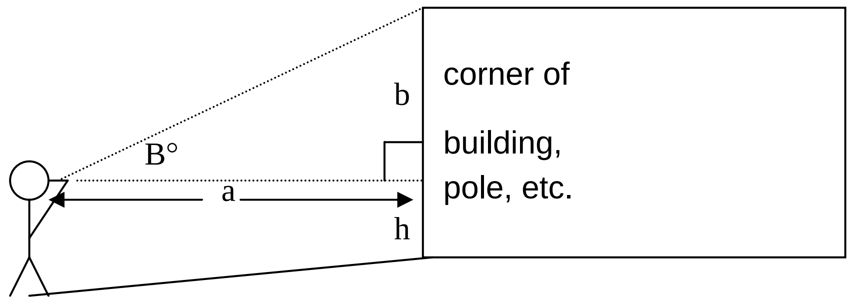
- Glue or tape the protractor to the piece of cardboard so that the zero line of the protractor is on the edge of the cardboard.
- Tape the straw on the edge of the cardboard along the zero line of the protractor.
- Attach the string to the center vertex of the protractor.
- Attach the weight to the bottom of the string.

Collecting the Data

At Six Flags, use your clinometers (or clinometers), measuring tapes, pencils, and paper, to gather data. Give all measurements in reasonable units.

You will work in a group of three to five students. Partners are very important in this project. Each person will make his own sightings, while the partners help take measurements. Within a group, the measurements should all be different. To ensure this, all group members should stand at different distances from the structure. But it is important that each person stand in the same spot to make all of his/her measurements. In your summary you will mention specifically how each person in your group helped you.

You will be using right triangle trigonometry, so you must have a right triangle to work with. It would be nice if the buildings or other structures formed right angles with the ground, but you are not always that lucky. You will need to "make" a



right triangle. Study the diagram.

- To find "h" you will need to use a measuring tape that you and your partners will have prepared before going outside. (This can be made from a piece of adding machine paper on which you have marked increments of one inch.) Someone in your group should hold the piece of paper on the corner of the structure. You are to look through your clinometer at a 0° angle. One of your partners will look at the clinometer to make sure that your angle is exactly 0°. Another partner should be standing at the corner of the building. You are to direct that partner to take a reading on the measuring tape at the height you see when looking at a 0° angle.

  h = ________________

- To find "a" you will need to carefully stretch a measuring tape so that it does not sag and read the distance. You will need the help of your partners to do this.

  a =________________

- To find the measure of the angle of elevation to the top of the building, use your clinometer.

  B = ________°

- Now calculate b by using the correct trig function. Show work below.

  b = ________________

- For the total height of the corner of the building/pole, add “h” and “b.”

The total height of the building/pole is _______________.

- What heights did the rest of your group find? ______________________

- What was the average height determined by your group? ___________

Preparing the Report

On graph paper make an accurate scale drawing, including all the measurements and the scale you used to make the drawing.

Write a brief summary answering the following questions. This summary should be typed.

- What is your calculated height of the building? Do you think this is a reasonable estimate? Why or why not?
- How long did it take you to complete the task?
- What difficulties did you encounter in completing the task?
- What did each of your partners do in helping you take measurements?
- What suggestions do you have for improving this project?
- Would you recommend this project for future trig classes? Why or why not?

Review your work for errors in spelling and grammar.

Turn in this entire handout, along with your scale drawing and summary.

☺☺
☺☺☺☺☺

To make 100% on the project, all criteria in the following scoring rubric must be met:

- All required papers are turned in: complete handout, scale drawing, report, and any other work done on the project.
- The scale drawings accurately depict the problem and show all measurements, including the scale used.
- All questions are answered completely and accurately, with work shown where needed.
- The computed height of the building/structure is reasonable.
- There are no mathematical errors.

- Report was well written, with spelling and grammatical errors not significantly affecting the communication of ideas.

If you turn your project in by the due date, your teacher will evaluate it. Then, if your project does not meet all the criteria, you will be given the opportunity to work more on it to bring it up to that standard.

You may earn bonus points on your project by including the following: Interview an engineer or someone else who may use trig to take measurements in his/her work. Or using the Internet or other resource, research some use of trig in a comparable setting. Prepare a brief report (at least ½ page typed). Include information about your source(s).

Name ____

Project Checklist

_____ All papers turned in

_____ Value of “h”

_____ Value of “a”

_____ Measurement of angle

_____ Value of “b” (with work shown)

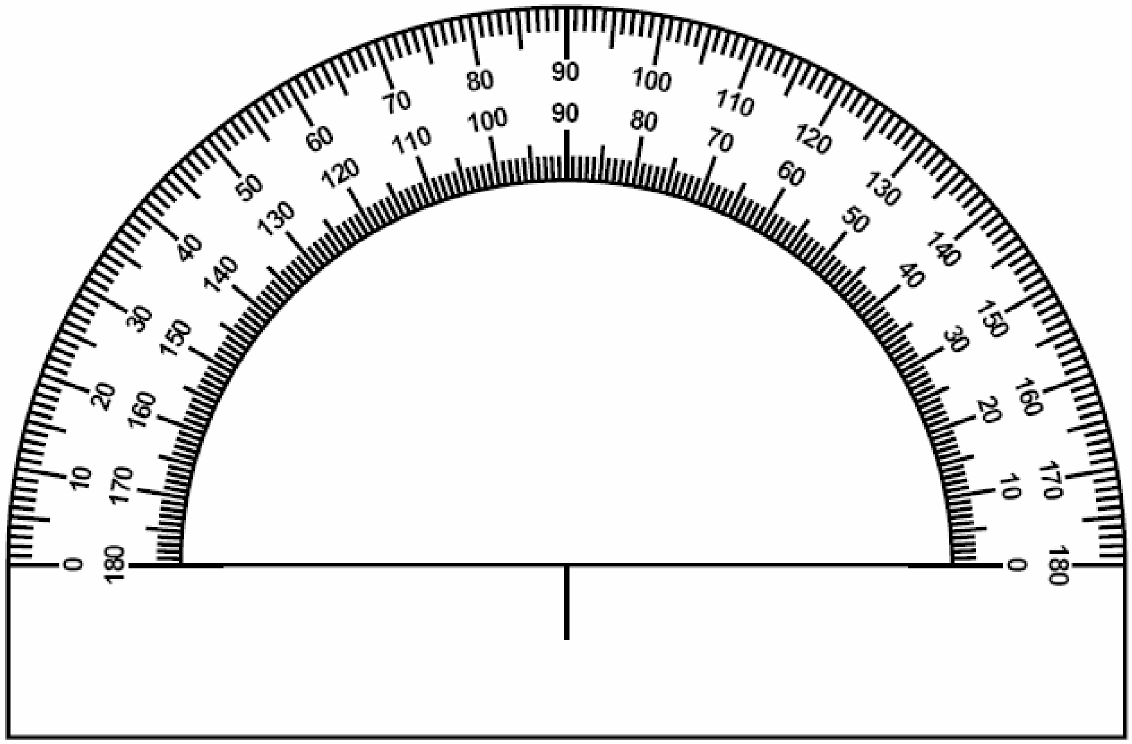
_____ Total height of the building

_____ Average height of the building for your group

_____ Accurate scale drawing (including all measurements and scale used)

_____ Report answers all questions and is well written

- What is your calculated height of the building? Do you think this is a reasonable estimate? Why or why not?
- How long did it take you to complete the task?
- What difficulties did you encounter in completing the task?
- What did each of your partners do in helping you take measurements?
- What suggestions do you have for improving this project?
- Would you recommend this project for future trig classes? Why or why not?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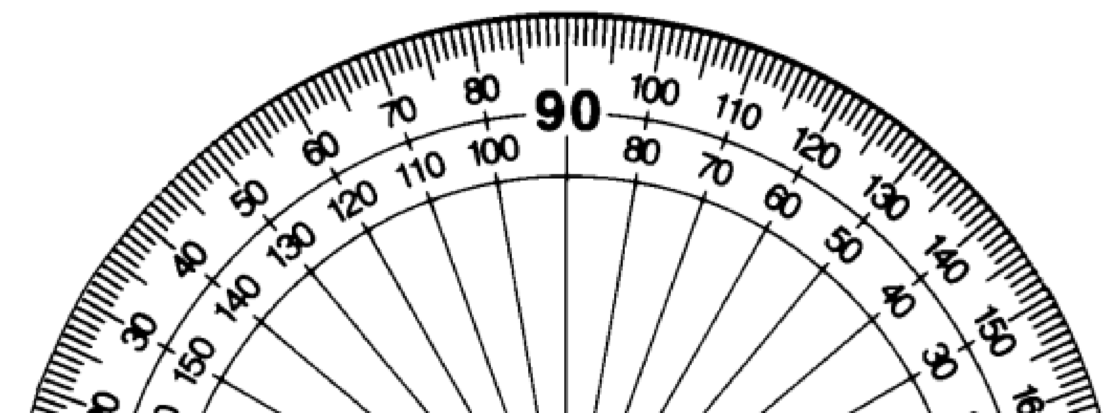
180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0


0 10 20 30 40 50 60 70 80 90 100 110 120 130 140 150 160 170 180
180 170 160 150 140 130 120 110 100 80 70 60 50 40 30 20 10 0